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ON THE ANATOMY AND LINGUAL DENTITION OF *ARIOLIMAX* AND OTHER PULMONATA.

BY W. G. BINNEY.

I have already, in connection with my friend Mr. T. Bland, given a description of the external characters of *Ariolimax* (Ann. N. Y. Lyc., N. H. X. 297, 1873). I now propose to describe such of its internal organs as I have been able to study.

I have examined one specimen of *Ariolimax niger*, J. G. Coop., preserved in spirit, belonging to the state collection of California, labelled and presented by Dr. Cooper, and in all respects an authentic type. Agreeing with this type I have other specimens from various California localities, so that I believe the species to be well established and generally distributed along the coast of California.

From the Museum of Comparative Zoology at Cambridge, Mr. Anthony has sent me a specimen, long preserved in alcohol, marked from San Mateo, California. For reasons given below, I am inclined to consider this the form described by Dr. Cooper as *A. Californicus*. I have had the opportunity of examining another specimen of this form, received from Mr. Stearns, who collected it near San Francisco.

From Mr. Henry Hemphill I have received a specimen from San Mateo Co., California, which presents most decided specific differences from the last-mentioned form, especially in its genitalia. Having considered the last-mentioned form as *A. Californicus*, I am forced to consider this as *A. Columbianus*, the only remaining described species. It must be borne in mind, however, that I have never compared it with specimens from more northern regions, whence the species was originally described. The large number of specimens formerly preserved in the Smithsonian, tabulated in Land and Fr. w. Shells, Part I. p. 281, were destroyed at the fire in Chicago, and I have been unable to obtain elsewhere any specimens from Oregon or Washington Territory, which I can refer to the true *Columbianus*.

In treating these various forms, I have abstained from giving any description of their exterior markings. Such description would be unreliable, as the specimens have been long preserved in

alcohol, and are evidently in various degrees of contraction. I will say, however, that I found in all the blind sac under the mouth (well marked, though not very deep), which is suspected by Dr. Leidy to be the seat of the olfactory nerve.

I can also here refer to several external characters not affected or obliterated by contraction in alcohol. All the specimens have a distinct locomotive disk to the foot. In all, the orifice of respiration is decidedly posterior to the middle of the right margin of the mantle. The position of the anus I found in *A. Columbianus* to be posterior and inferior to the respiratory orifice, with a gutter-like groove to the edge of the mantle. The position of the orifice of the generative organs is not so easily decided in alcoholic specimens. I have no doubt, however, that in the living animal it is under the mantle, not close behind the right tentacle. In one form, *Ariolimax Californicus*, there are beyond doubt two distinct orifices; that of the male being smaller and anterior. In Dr. Cooper's figure of *A. Californicus* (Proc. Phila. Ac. Nat. Sc. 1873, pl. iii. f. D 3) the two orifices are plainly shown, and suggested to me the identity of my specimens with his species, especially as the external markings also agreed with his description. In *A. Columbianus*? also there is no common duct or cloaca, as Dr. Leidy calls it, to the genitalia, though I could not detect more than one exterior orifice. In *A. niger* there can be but one common orifice, judging from the penis entering into the common cloaca, as shown in my fig. c of plate XI.

The mantle is free on its margin in its whole circumference, especially in front and on its sides as far back as the respiratory orifice. I could detect no concentric lines or other markings on the mantle. The mantle was greatly produced and swollen on its margins in Mr. Stearn's specimen of *A. Californicus*. In that and all the specimens examined I found an internal shell, varying somewhat in thickness, but always well marked, calcareous, subhexagonal, longer than wide. In the specimen of *A. Columbianus*? there were decided concentric lines of growth on the shell, as will be seen in my fig. a, plate II.

The caudal mucus pore was plainly visible in all the specimens of *A. niger* which I have examined. In fig. A of plate II. I have figured the pore of this species. It seems to be in two portions, one erect, triangular, at the end of the body of the animal, with another running at right angles with it in a gutter-like excava-

tion towards the extreme end of the tail. In the form I have referred to *A. Columbianus*? the pore was quite different from this, as seen in my figure B of plate II. In this the erect portion of the pore is entirely wanting, the carinated body being arched regularly down to, and overhanging the foot. The longitudinal gutter-like pore is, however, plainly visible. In the two specimens of the form I have referred to *A. Californicus*, the body is also arched down to, and overhangs, the foot. On the tail, corresponding to the gutter-like pore of the last-mentioned form, there was no sign of any pore, but in its place the flesh was sponge-like, without the markings which are found on the neighboring portions of the foot. It may be, therefore, that in these specimens the mucous pore was contracted or closed. No doubt it exists in the living animal.

Of the internal anatomy I have examined the nervous system in both *A. Californicus* and *A. Columbianus*? The ganglia present the usual three sets, all globular in form, and so crowded together in the subœsophageal and superœsophageal as almost to form a continuous chain around the buccal mass.

In these same two forms, also, I have examined the circulatory and respiratory organs. Within the respiratory cavity is a large, spongy, ear-shaped organ, attached only at one point to the roof of the chamber. This, I suppose to be the renal organ, surrounding, and indeed inclosing, the heart, though it is not so arranged in any of the genera described by Dr. Leidy. In *Arion hortensis* he describes the nearest approach to such an arrangement.

I have examined the digestive system of all the forms, and figured that of both *A. Californicus* and *Columbianus*. In the latter, plate II. fig. D, F, the buccal mass (1) is large and round, the salivary glands (4) short and broad; the stomach (5) long and large, with a decided constriction at its middle, and the usual cul-de-sac (6) at its extremity, at which point the biliary ducts (7, 7) enter; from this the stomach passes into the intestine (8), which proceeds first forward almost to the œsophagus, thence proceeds backward to the extreme rear of the general cavity of the body, and again forward to below the respiratory cavity, into which it penetrates upwards as the rectum (9), and through which it passes to the anus, whose position is described above. The intestine in its whole course winds among, and is imbedded in, the

various lobes of the liver, which latter organ is arranged as usual in *Limax*, *Arion*, etc.

In *A. Californicus* (plate XI. fig. E), there is a difference in the arrangement of the stomach. Before reaching the cul-de-sac (6), the stomach is greatly constricted, and the cul-de-sac runs at right angles with the stomach in an erect position, not lying on its side as I have represented it, in order to show the connection between it and the anterior portion of the stomach, which connection was entirely concealed by the cul-de-sac in its upright position. The extreme length of the digestive system is three times that of the whole body of the animal, at least in its contracted state.

The jaw in all the forms of *Ariolimax* is quite thick, dark horn-colored, arcuate; ends but little attenuated, blunt; anterior surface with stout ribs, denticulating either margin. I have figured the jaw of *A. Columbianus*? (plate II. fig. H) which has about twelve ribs. In *A. Californicus*, from Mr. Anthony, there were thirteen ribs to the jaw; fourteen in Mr. Hemphill's specimen of the same. In *A. niger* Dr. Cooper describes about twenty, but in one specimen I found but eight. In Land and Fr. w. Shells, I. p. 280, I have figured a jaw of the true northern form with eighteen ribs.

The pouch of the lingual membrane is shown in plate II. fig. D, 5. The membrane is as usual in the *Helicidæ*, with tricuspid central, bicuspid lateral, and quadrate marginal teeth showing simply a modification of the laterals. In L. and Fr. w. Shells, I. p. 280, I have figured the lingual membrane of the true northern *A. Columbianus*. The marginal teeth are there shown to have one long denticle and a small, subobsolete side denticle. This form of marginal teeth I have found in the form I have referred to *A. Columbianus*? (see plate II. fig. E). Also in one of Dr. Cooper's types of *A. niger* (plate XI. fig. A), and in both the specimens of *A. Californicus* (plate XI. fig. G). This form of marginal tooth may therefore be considered characteristic of the genus, though in one specimen supposed to be *A. niger*, I noticed marginal teeth with the outer cusp much more developed and bifid, and figured them in Ann. Lyc. N. H. N. Y., x. pl. xiii. fig. 1. In plate XI. fig. B, I have given the central and the adjoining lateral teeth of *A. niger*. In fig. F, the central and one adjoining lateral of *A. Californicus*.

There is no retractor muscle to the buccal mass in *A. Califor-*

nicus and *A. Columbianus*?, but a very stout, broad one to the whole head, attached to the outer integument, below the buccal mass, and running along some distance on the floor of the general visceral cavity, to which finally it becomes attached.

In describing the genital organs I have used the terms applied to the various organs by Dr. Leidy in the first volume of my father's work on "The Terrestrial Mollusks of the United States." Each form examined presented differences in these organs. They all agree, however, in having a very large ovary.

On opening the body of *A. niger* (plate XI. fig. c), the genitalia are found in the usual place, the testicle lying quite at the rear of the visceral cavity near the extreme point of the upper lobes of the liver, hardly imbedded in it, connected to the ovary by a long epididymis (2). The testicle (1) is globular in form, composed of black, aciniform cæca. It contrasts in color with the dirty white of the liver. Color, however, I have not found constant in the internal organs of land shells preserved in spirits. The above described arrangement of the testicle is as usual in *Limax*, *Arion*, and other slugs. It forms an excellent specific character for *A. niger*, the position of the testicle being quite different in *A. Californicus* and *A. Columbianus*?, as will be seen below. The epididymis (2) is long, convoluted at the end nearer the ovary. The accessory gland is shown in 3. The ovary (11) is large, yellowish. The oviduct (8) and prostate (4) show no unusual characters. The genital bladder (9) is large, oval, with a short duct (16). The penis is in a short, stout sac (5), which has a bulb-like swelling at its upper extremity, where the vas deferens (7) enters. The latter organ has nothing of peculiar interest. A vaginal prostate, or perhaps dart sac, is shown in 13. The external orifice is described above (p. 34).

The genital system of *A. Californicus* is figured in D of plate XI. The testicle does not lie far away, imbedded in, or resting on, the upper lobes of the liver, but lies close against the ovary, in the semicircle formed by the recurving of the apex of the ovary upon itself. In this respect, the position of the testicle is different from that of most slugs, and affords an excellent specific character. The testicle (1) is kidney-shaped as it is covered by its investing membrane. It appears to consist of closely bound fasciculi of short, white, tubular, not aciniform cæca. The epididymis (2) is short and still more shortened by its excessive

convolution. The accessory gland is shown in 3, partially imbedded in the ovary. The ovary (11) is large and distinctly lobulated. The oviduct (8) is narrow, very long, greatly convoluted. From the testicle to about the middle of the course of the oviduct is a stout thread-like organ, of unknown use to me, either a muscle, nerve, or duct. It is not figured in my plate, as I am not certain of its forming part of the genital system. The genital bladder (9) is oval, large, with a short, stout duct (16). The penis is inclosed in a long tapering sac (5), terminating in a decided flagellum (15), in which I detected no capreolus. On the end of the flagellum is a large, globular bulb. The retractor muscle of the penis is attached to the roof of the general visceral cavity, below the pulmonary chamber. It joins the penis at the commencement of the flagellum. The vas deferens (7) is peculiar. It leaves the prostate gland (4) as usual, runs alongside of the vagina to the base of the penis, thence runs upwards, swelling to an enormous extent, so as to equal the breadth of the penis, then again becomes gradually reduced to its former size until, as the most delicate thread, it enters the penis at the end of the flagellum below the bulb. The penis did not appear in the animal extended as drawn in the plate, but was twice recurved upon itself. There is also a vaginal prostate (13), large, ear-shaped, close to the exterior orifice of the female organs, which, with that of the male, is described above (p. 34).

On plate II. fig. c, I have figured the genitalia of *A. Columbianus*? which also has a very large ovary (11) against which the testicle (1) lies as in the preceding form. The ovary is so large as to take up one-half of the entire visceral cavity, extending completely across the body, resting on the floor of the cavity, its ends recurved upwards so as to rest upon the liver on the upper surface of the viscera. The body of the animal externally is swollen by the large size of the ovary. The oviduct (8) is narrow, long, greatly convoluted, ending in an extremely long, convoluted vagina. The genital bladder (9) is oval, large, with a short, stout duct (16). The vas deferens (7) unlike that of the preceding form, is as usual in the land shells. It enters the penis (5) at its summit, opposite the retractor muscle (6). The sac of the penis is very stout, long, cylindrical. The external orifice is described above (p. 34).

Zonites lævigatus, Pfr., pl. III., fig. 1.

I have examined numerous specimens, but have some hesitation in giving my figure and description as absolutely perfect. I had great difficulty in dissecting the species.

The ovary is short and vagina long. The genital bladder with its duct forms a short cylindrical sac-like organ, opening near the base of the vagina, and tapering at the apex. The penis sac is long, cylindrical, larger at its apex where it receives the vas deferens. At its base the penis sac has its opening into the vagina with a short stout organ (fig. 13) with rounded apex, where a retractor muscle seems to be attached. This organ may be a dart sac or some form of prostate gland.

Hemphillia glandulosa, Bl. and Binn., pl. III., fig. v. vi.

The testicle is composed of a large globular mass of aciniform cæca. It lies loosely upon, not imbedded in, the upper lobes of the liver. The ovary and oviduct are as usual. The genital bladder is globular, very large, on a short stout duct, entering the vagina near its base. The penis sac is long, cylindrical, larger towards its apex, where both the retractor muscle and vas deferens enter.

In several specimens examined, the penis sac appeared somewhat different. It had a large globular bulb (5a) at its apex. The vas deferens (7) entered beyond the middle of the length of the sac (5); it was greatly swollen (5b) before entering the sac, for a distance equalling about one-half of the length of the sac. At the commencement of this swelling the retractor muscle (6) was inserted. This form of penis sac is figured in fig. vi.

The balance of the anatomy of *Hemphillia* seems to be as in the other slugs.

Helix Kelletti, Forbes (*Arionta*), pl. III., fig. iv. The Catalina Island form.

The ovary is light yellow. The oviduct is white. The genital bladder is light yellow. The prostate is large and yellow.

The whole genital system is long and narrow. The genital bladder is small, globular, on an extremely long and delicate duct which enters the vagina at its upper end. The duct just below the bladder receives a branch duct, very long, flagellate, three times the diameter of the duct itself. The penis sac is long, stout, cylindrical, tapering towards its apex and prolonged into a very long delicate flagellum. The vas deferens enters at the point

where the flagellum commences. The retractor muscle is inserted half way between the vagina and the entrance of the vas deferens. Opposite the mouth of the penis sac is a small sac-like organ, probably a dart sac or vaginal prostate.

Helix Mitchelliana, Lea (*Mesodon*), pl. III., fig. III.

The genital system is long and narrow. The oviduct is greatly convoluted. The penis sac is long, stout, cylindrical, with a bulb-like expansion at its apex, at which point both vas deferens and retractor muscle are inserted. The genital bladder is lengthened, ovate, not much larger than its duct, which is short, and enters the vagina below the middle of its length.

Helix reticulata, Pfr. (*Arionta*), pl. III., fig. II.

The specimens examined have a very globose shell. The ovary is brownish below, yellowish above. The epididymis and testicle are salmon colored. The oviduct is white, the prostate salmon. The genital bladder is small, oval, with an extremely long duct, which has a flagellate branch. The duct enters at the lower end of the vagina. The penis is narrow, cylindrical, extremely long, with a flagellate extension. The retractor muscle is inserted beyond the middle of the length of the penis, the vas deferens at the commencement of the flagellum. There is a stout long cylindrical vaginal prostate, whose apex is extended into a flagellum, which shortly becomes bifurcate, there being a bulb-like expansion on each branch just beyond the bifurcation.

In some individuals the bulb-like expansions are still larger and stouter than in the figure. The cylindrical extension of the vaginal prostate is abruptly truncated, the two flagella entering near the end, not at the extreme terminus.

Helix Roemeri, Pfr. (*Mesodon*).

The genitalia are figured on pl. IV., fig. v. The oviduct is scarcely convoluted. The genital bladder is large, oval, with a long, large duct. The penis sac is short, stout, of about equal breadth throughout, ending in a stout oval bulb, into which the vas deferens enters. The retractor muscle is inserted above the entrance of the vas deferens.

The specimen examined was collected in Bosque County, Texas, by Mr. Hugo W. Ericsson.

Helix appressa, Say (*Triodopsis*).

The genitalia are figured on pl. IV., fig. IV. The ovary is long

and narrow. The epididymis is very long, convoluted at the end nearer the oviduct. The last-named organ is not much convoluted. The prostate is scalloped along its edges. The genital bladder is globular, small, with a long, small duct. The sac of the penis is extremely long, ribbon-like, one and one-half as long as the oviduct. The vas deferens enters its apex.

The long ribbon-like sac of the penis resembles that figured by Dr. Leidy (Terr. Moll. U. S. I.), of *H. Sayii*. There is but little resemblance to the genitalia of *H. palliata*, so nearly allied by its shell.

The specimens examined were collected in eastern Tennessee, by Miss Law.

***Helix Nickliniana*, Lea (*Arionta*).**

The genitalia are figured on plate IV. fig. III. The ovary is yellow, long, narrow, concave on one side, convex and carinated on the other. The accessory gland of the epididymis is composed of long, white cæca. The oviduct is extremely long, narrow, convoluted. The genital bladder is globular, small, with an extremely long duct, to which is added an accessory duct or branch, almost as long as the oviduct. This branch joins the duct near its end. It is thicker than the duct. The duct enters the vagina at its upper part. The penis sac is long, cylindrical, small, almost equalling in length the oviduct and ovary united. The retractor muscle is inserted at about the middle of its length, it is attached to the diaphragm; the vas deferens enters about three-fourths of its length; beyond the vas deferens is a flagellate extension. The vagina is long and narrow; near its base, opposite the entrance of the sac of the penis is a stout, cylindrical, long, hollow, vaginal prostate, gradually tapering at its apex, and extended into a delicate tube, which soon becomes divided into two long flagella. Just beyond the division, on each flagellum, is a stout bulb-like enlargement.

This complicated form of genitalia, hitherto unnoticed in American species, has been noticed in European species.

***Patula strigosa*, Gould, pl. IV., fig. II.**

Represents the genitalia of a Salmon River specimen. The testicle, as usual, was in the summit of the upper lobe of the liver. The epididymis is long, convoluted in its half nearer the testicle. The accessory gland is composed of several long, black cæca. The oviduct is sac-like, not convoluted, containing eight embryonic

shells. The genital bladder is long, with a long, narrow duct entering the upper part of the vagina. The vagina is short and swollen. The penis sac is long, stout, blunt at apex, where the retractor muscle is inserted. The vas deferens becomes greatly swollen before it enters the sac of the penis, which it does above the insertion of the retractor muscle.

As the shells of some forms of this species are difficult to distinguish from some forms of *Patula solitaria*, it is interesting to state that the genitalia of a specimen of the latter from the same locality, offer very distinct specific characteristics, agreeing with Dr. Leidy's figure in Terr. Moll. U. S. I.

Macrocyclus Vancouverensis, Lea.

The genitalia are figured on pl. IV., fig. 1. The epididymis is extremely long and very large, forming the peculiar feature of the system. The genital bladder is oval, with a long duct, which is very much broader at the end nearer the vagina. The penis sac is long, gradually tapering at its apex, where it receives the vas deferens. Upon the side of the vagina, about the middle of its length, is a wart-like protuberance, which may be a dart sac or a vaginal prostate.

A comparison of Dr. Leidy's figure of the genitalia of *M. concava* in Terr. Moll. U. S. I. shows considerable difference between the two species, especially in the epididymis.

Zonites demissus, Binney.

The genitalia are like those of *Z. intertextus*, Binney, figured by Dr. Leidy (Terr. Moll. U. S. I.). The accessory glands of the dart sac are rather shorter in *demissus*.

Amphibulima appendiculata, Pfr.

Elsewhere (Ann. Lyc. Nat. Hist., N. Y. x. 206, pl. ix. f. 2, 6, 9, 11) we have fully described the external appearance, jaw, lingual membrane, and shell of this species, pointing out its differences from *Succinea*, from *Pellicula*, from *Omalonyx*, and all other described genera.

I now give (pl. VIII. fig. 5) a figure of its genital system, with notes on other organs, *drawn from specimens in alcohol*.

The external orifice of generation is behind the right eyepeduncle. The orifice of respiration is on the right margin of the mantle, slightly to the rear of its middle. There is a distinct locomotive disk to the foot. The eyepeduncles must be short and stout. The digestive and nervous systems present no remarkable feature.

The subœsophageal ganglia consist apparently of six closely agglomerated globules. There are two simple globules to the stomacogastric ganglia. The genital system (pl. VIII. fig. 5) is quite simple, presenting no accessory organs. The testicle is composed of six or seven fasciculi of long cæca, which massed together in a globular form equal the length of the oviduct. This enormous development of the testicle is the peculiarity of the genital system, and no doubt will prove a reliable specific, but not generic, character. The epididymis is long, convoluted at its middle portion. The oviduct is long, narrow, not convoluted. The vagina is about one-fifth the length of the oviduct; it is swollen greatly at the entrance of the penis. The genital bladder is small, globular; its duct is narrow, longer than the oviduct, and enters the vagina at the upper fourth of its length. The penis sac is short, stout, blunt at apex, where the vas deferens enters and where the retractor muscle is also inserted.

In the paper referred to above we hesitated to decide upon the generic position of this species, leaving it temporarily in *Pellicula* of Fischer (not of Heynemann, which is *Omalonyx*). Since that time I have become acquainted with the jaw of *Amphibulima*, and find it to be of the same type as in *appendiculata*. I would, therefore, suggest that this species belongs to *Amphibulima*. It is true its lingual dentition (see pl. VIII. fig. 6) more closely resembles that of *Simpulopsis sulculosa* as far as centrals, and perhaps laterals, are concerned; but in the marginals, as described in *S. sulculosa* and *S. Portoricensis*, the resemblance ceases. Moreover, the jaw of *Simpulopsis* is described as quite different by Shuttleworth. The species under consideration cannot, therefore, be placed in *Simpulopsis*. It appears, at all events, that the shell in this group is an unreliable guide to generic position.

It must be borne in mind that I here describe the anatomy of the shell figured by us (l.c.). We believe it to be *Succinea appendiculata*, Pfr. Fischer bases his genus *Pellicula* on *Succinea depressa*, Rang. He does, indeed, place *S. appendiculata*, Pfr., in the synonymy of his species, but our specimens of *appendiculata* could never be the same as Fischer's specimens of *depressa*. His had a jaw with nine decided ribs, denticulating the cutting edge, and teeth¹ of the usual form of *Helicinæ*, quite different from what

¹ In Fischer's plate the references to teeth of *Omalonyx unguis* and *Pellicula depressa* are reversed.

we find in our *S. appendiculata*. His species and ours are therefore distinct.

Pellicula convexa, Martens (*Succinea*), is quite a distinct species, and belongs to the genus *Omalonyx*, as shown by Heynemann's figure of the jaw (Mal. Blatt., xv.).

I give also figures of the central and lateral teeth of our species (pl. VIII., fig. 6).

***Amphibulima patula*, Brug.**

I have elsewhere described, in connection with Mr. Bland, the jaw and lingual membrane of specimens of this species from St. Kitts and Dominica (Am. Journ. of Conch., VII. 186, pl. xvii., f. 1, 2; Ann. Lyc. N. H. and N. Y., x. 225, pl. xi., f. 8). Lately the question of identity of these shells with the Guadeloupe *patula* has been raised (see Journal de Conchyliologie, XXI. 12). I have, therefore, again carefully examined the lingual membranes previously described to learn if they give any difference worthy to be considered of specific value. I have figured teeth from each lingual membrane (pl. VII.). I regret not having had the opportunity of examining Guadeloupe specimens also, but have never been able to receive the latter with the animal; indeed it seems to be now found subfossil only. I can only treat the question of the identity of the St. Kitts and Dominica forms, not their identity with Guadeloupe forms.

It will be seen that the Dominica form has sharper cutting points to the large cusps of its central and lateral teeth than that of St. Kitts. Fig. B shows a group of laterals of the former, in which some variation from the pointed shape is indeed shown, but no decided tendency that way. On the other hand, the laterals, from the St. Kitts form, show great constancy in the square truncation of the cutting points.

The teeth of the St. Kitts form are broader in proportion to their length than those of Dominica, have a greater curve in their outlines, and more developed side cusps, which overlap the median cusps.

The Dominica lingual in the only row counted had 87-1-87 teeth. A row of the St. Kitts form 57-1-57. The marginal teeth of the St. Kitts form show a greater tendency to splitting into sharp denticles on the cutting cusps than those of Dominica.

It cannot be denied that certain variations may be noticed in the two lingual membranes. I believe, however, that these differ-

ences are not such as suggest specific distinction, especially as the shell furnishes no grounds for doubting the specific identity of the forms. Nor by the shell alone does there seem to be two species.

Mr. Bland has given a detailed account of the species in *Journal de Conchyliologie*, XXI. 342, October, 1873.

***Amphibulima rubescens*, Desh.**

Mr. Bland and myself are indebted to Governor Rawson for specimens preserved in spirits of *Succinea rubescens*, Fér. of Martinique.

On examination of the jaw and lingual membrane, I found the species to be no *Succinea*, but an *Amphibulima*, in which genus it is placed by H. and A. Adams (Gen. Rec. Moll.), and by Beck (Index), though Pfeiffer treats it as a *Succinea*, and von Martens catalogues it in *Succinea*, s. str. (See note 1 to p. 345 of *Journ. de Conch.*, Oct. 1873, 3d series, XIII.)

The external appearance of the animal has nothing peculiar. The head appears blunt and short, the tail long and pointed, without any mucus pore. There is no distinctly marked locomotive disk to the foot, over the whole breadth of which the transverse muscles pass. The reticulations of the surface of the animal seem large and coarse in proportion to its size. As far as can be judged from alcoholic specimens, the tentacles and eyepeduncles seem short and stout. The respiratory and anal orifices are under the mantle on the right side. The external orifice of generation is behind the right eyepeduncle.

On opening the animal from above, the generative system is found as usual, lying on the right of the animal. It occupies the whole of the visceral cavity in front of the shell, lying upon the stomach. The testicle (see plate VIII., fig. 4) is a globular mass composed of long cæca. It lies imbedded in the liver. The epididymis is not greatly convoluted. It passes between the stomach and intestine, at the cul-de-sac of the former, on its way to the ovary. The latter organ is, as usual, tongue-shaped. The oviduct is long and greatly convoluted. The vagina is short, receiving at its lower portion the long duct of the small, globular genital bladder. The penis enters the vagina close to the common opening. The sac of the penis is not long, is stout, cylindrical, blunt at apex, where it receives the vas deferens, just above the insertion of the retractor muscle. There are no accessory organs. The genital system is very much the same in its general arrange-

ment as that of *Amphibulima appendiculata*, Pfr. (see fig. 5), but differs among other things in wanting the huge testicle of that species.

The digestive system presents no peculiar characters. The stomach is long, narrow, and ribbon-shaped, lying under the genital system and extending backward as far as the shell when the animal is extended. At this point the stomach forms the usual cul-de-sac at its junction with the intestine. The last organ and the liver are small in proportion, as would be anticipated from the short spire of the shell; the liver is dark blue. There seems to be a retractor muscle to the whole head rather than to the buccal mass. It lies on the floor of the cavity. The buccal mass is large, the œsophagus small. The salivary glands and ducts, and pouch of the lingual membrane are as usual. The jaw is readily detached from the muscles of the mouth, and is not connected with the lingual membrane as usual with our *Helices*.¹ It is thin, wide, low, arched, with attenuated, bluntly pointed ends; divided by numerous (about 63) delicate ribs into separate plate-like divisions, as in the jaw of *Cylindrella*, *Bulimulus*, etc., the ribs running somewhat obliquely towards the centre of the jaw; there is no decided, upper median, triangular plate (fig. 2, plate VIII.). The lingual membrane (plate VII., fig. 3) is long, broad, composed of numerous rows of 76-1-76 teeth. Centrals long, narrow, expanding below with the lower margin squarely excavated as in *Succinea*; tricuspid, the central cusp very long, wide, with a greatly expanded, squarely truncated cutting point reaching beyond the lower margin of the tooth; the side cusps short and narrow, simply pointed. The lateral teeth are of same type as the centrals, but unsymmetrical and bicuspid. The marginals are a simple modification of the laterals, with a long, bluntly truncated median cusp, and obsolete side cusps. The extreme marginals are irregularly denticulated, the outer and inner denticles being more produced, especially the outer, and greatly curved; the inner denticles, usually two in number, are quite small.

The jaw agrees perfectly with that of the genus *Amphibulima* described by us. (Ann. Lyc. N. H. of N. Y., x. p. 223, pl. xi.

¹ Even after boiling the whole buccal mass in potash, the lingual membrane and jaw remain attached in most of our *Helices* of N. A. showing a decided connection between the two.

fig. 8.) The lingual membrane has also the same general arrangement as in that genus, with specific differences from that of *A. patula* (see plate VII., fig. A-C), especially in the widely expanded, blunt median cusp, and in the *Succinea*-like cutting away of the lower margin of the teeth.

The nervous ganglia are as usual in the *Geophila*, forming a continuous ring in the supraesophageal, and grouped together in one mass in the subesophageal set.

Plate VIII., fig. 3, gives the central and adjacent lateral teeth, with marginals at different intervals to the edge of the membrane.

The notes we have given above will enable a full generic description of the genus *Amphibulima* to be drawn.

Gonospira and Nanina, from Mauritius.

Having received from the Museum of Comparative Zoology at Cambridge a number of specimens in alcohol of Mauritius species, collected by Consul Pike, we are able to give the following notes on them.

Gonospira. There were several species of this and the allied subgenera, allowing an examination of their anatomy. The soft parts of the animals are colored red. The species especially examined are *G. Newtoni*, H. Ad., and *G. palanga*, Fér. There seems nothing in the anatomy different from what is usual in the land shells. The genitalia of *G. Newtoni* are figured on plate VIII., fig. 7. There are no accessory organs. The genital bladder is long, oval, with a long, narrow duct. The penis sac is stout, long, receiving the vas deferens at its summit, at which point, also, the retractor muscle is inserted. The vagina is long, the oviduct not convoluted. The ovary tongue-shaped as usual. The epididymis is short, the testicle as usual lies in the liver.

G. palanga has a similar genital system. There appears no locomotive disk and no caudal pore.

The lingual membrane of the genus has been photographed by Mr. Bland and myself (Am. Journ. of Conch., v. pl. xi. fig. 1). All the species now received have similar dentition. There is, however, a difference in the number of teeth in each transverse row. I counted about 37-1-37 in *palanga*; 6-1-6 in *G. Newtoni*; 12-1-12 in *G. mauritiana*, Morelet; 25-1-25 in *G. modiolus*, Fér. (*Gibbulina*, v. Martens). The dentition of this species is also described by Semper (Nachr. Mal. Ges., II. 103). 21-1-21 in *G.*

Nevilli. We have elsewhere described the dentition of *G. sulcata*, Müll. (Ann. N. Y. Lyc. N. H., x. 222).

No jaw was found in any of the above, nor in *Ennea clavulata*, Lam. This last species is placed in s. g. *Gulella* by von Martens. There were five embryonic shells in the oviduct, proving the species to be viviparous. The dentition is the same as in *Gonospira*. There appears to be a median tooth of same form as the laterals.

Of the genus *Nanina* (using the name in the same sense as von Martens in die Heliceen), there were several species. All have the locomotive disk, the caudal pore with overhanging horn-like projection, the smooth jaw with median projection, and the lingual dentition of the genus, *i. e.*, centrals tricuspid, laterals bicuspid, marginals aculeate, bluntly bifid. Such are *N. Caldwelli*, Benson; *N. Rawsoni*, Barclay = *semicerina*, Morelet; *N. argentea*, Rve.; *N. implicata*, Nevill; *N. stylodon*, Pfr., put in *Helix (Erepta)* by von Martens. Entirely different in the dentition is another species, *N. philyrina*, Morelet, though the species agrees in other respects with the above-named. The membrane is very broad, the teeth exceedingly numerous, arranged in oblique rows. The centrals, which I am confident of having seen, are small, narrow, high. The other teeth are the same in form to the edge of the membrane. They appear to have the usual aculeate form of the marginal teeth in *Nanina*, but instead of narrowing towards the cutting point, they are broadly and obliquely truncated, reflected, and minutely denticulated. This lingual membrane is also figured by Semper (Phil. Archip., pl. vi. f. 35), but his figures give more the impression of the usual *Nanina* marginals with denticulated side and bifid points. The teeth are, however, so exceedingly numerous and small, it is very difficult to understand them.

Elsewhere (Ann. N. Y. Lyc. N. H., x. 170) we have described the lingual of the following Mauritius species: *Nanina inversicolor*, *leucostyla*, *rufizonata*, *militaris*. I have examined the genitalia of *N. inversicolor*. The oviduct is long, narrow, sac-like; the genital bladder is hardly smaller than its long wide duct; the penis sac is long, extended into a flagellum, receiving the vas deferens near its apex, beyond it having a bulb-like termination; the vas deferens is greatly swollen at its middle portion, and near the base of the oviduct has a long flagellate appendix.

Glandina semitarum, Rang. (*Varicella*).

Martinique, Governor Rawson.

Lingual membrane as usual in *Glandina*. There are about 30–1–30 teeth. The central is long and narrow, sharply pointed.

Glandina Phillipsi, Adams (*Varicella*).

Jamaica.

Lingual membrane as in last species.

Helix clausa, Say (*Mesodon*).

Whitley Co., Kentucky. A. G. Wetherby.

Jaw as usual in the subgenus, with about 10 stout, separate ribs, denticulating either margin.

Lingual membrane long and narrow. Teeth about 41–1–41. Centrals and laterals (about 11 of the latter), as usual in the subgenus (see fig. of those of *H. Sayi*, L. and Fr. w. Shells, I. 154, fig. 265). Marginals quadrate, with one extremely long, oblique denticle, as in *H. thyroides* (l. c. fig. 252, p. 148). Some of the extreme marginals are notched or obsoletely bifid at their point.

The penis resembles that of *H. thyroides* as figured by Dr. Leidy in Terr. Moll. U. S., I.

Helix Downieana, Bland (*Mesodon*).

Whitley Co., Kentucky. A. G. Wetherby.

Jaw ribbed as usual in the subgenus. Lingual membrane as usual in the subgenus (see fig. 265 of L. and Fr. w. Shells, N. A., I). Marginals with one long, oblique, bluntly bifid inner denticle, and two short, blunt outer denticles.

Helix Wetherbyi, Bland (*Mesodon*).

Whitley Co., Kentucky. A. G. Wetherby.

Jaw and lingual membrane as usual in the subgenus (see *ante*, *H. clausa*), the former with about 18 ribs, the latter with marginals peculiar for the great development of the inner blunt denticle, the outer being short and blunt. Plate V., fig. 17, 18.

Helix Edwardsi, Bland (*Stenotrema*).

Whitley Co., Kentucky. A. G. Wetherby.

Jaw as usual in the subgenus (see L. and Fr. w. Shells, N. A., I), with about 13 broad, crowded ribs, denticulating either margin.

Lingual membrane as in *H. hirsuta* (l. c. 119, fig. 197). Centrals tricuspid, laterals bicuspid, marginals wide, low, with one

inner, long, oblique, bluntly bifid denticle, and two outer, short, blunt denticles.

***Helix angulata*, Fér. (*Eurycratera*).**

Porto Rico. From the late Mr. Robert Swift.

Jaw stout, dark claret-colored, low, wide, ends blunt; about 7, very wide, crowded, decided ribs, bluntly denticulating either margin.

Lingual membrane as in the *H. crispata* (plate X., fig. 9), as far as the general arrangement of the teeth, but there are decidedly developed points to the side cusps of both centrals and laterals; we have therefore figured it (plate IX., fig. 5).

***Helix Texasianna*, Mor. (*Polygyra*).**

Bosque Co., Texas. Mr. H. W. Ericsson.

Jaw wide, low, slightly arcuate, ends blunt, with 10 decided ribs, denticulating either margin.

Lingual membrane (plate V., fig. 1) as usual in the subgenus. Centrals and laterals with a plate about as wide as high, the former tricuspid, the latter bicuspid, cusps long and slender, with long, sharp points. Marginals low, wide, multidentate, the two inner denticles long, the several outer denticles short and slender. Of the same type as figured by us for *H. auriculata* in L. and Fr. w. Shells, I. 87.

***Helix Luquillensis*, Shuttl. (*Polydotes*).**

The lingual was received mounted from the late Mr. Robert Swift.

Lingual membrane (plate X., fig. 2-4) as usual in the *Helicidæ*. Centrals tricuspid, laterals bicuspid, cusps with long, sharp points, extending beyond the base of the plate. Marginals bicuspid, cusps short, bluntly rounded, the inner one, as usual, the longer.

We received no jaw of this species.

***Helix notabilis*, Shuttl. (*Thelidomus*).**

Tortola. Received mounted from the late Mr. Robert Swift.

Jaw arcuate, low, ends blunt; narrower at the centre; decided separate ribs, denticulating either margin.

Lingual membrane already published by us. (Am. Journ. Conch., VI. 177; see also plate IX., fig. 10). Centrals tricuspid, laterals bicuspid, the plates about as wide as high, the larger cusp with a long point extending beyond the lower margin of the

plate. Marginals quadrate, of equal width and height, with two short, wide, blunt, round cusps, the inner one slightly the larger.

Helix discolor, Fér. (*Thelidomus*).

Jaw arcuate, thick, ends blunt. Anterior surface with 7 unequal, decided, stout ribs, denticulating either margin.

Lingual membrane (plate X., fig. 1) long and narrow. Centrals with a long narrow plate expanded at the base, and bearing at its corners a small reinforcement; base of the plate extending beyond the cusp; bluntly tricuspid, the median cusp long, stout, with a short blunt point; side cusps subobsolete. Laterals as in the centrals, but unsymmetrical, and with a shorter plate. Marginals quadrate, wide as high, with two short, blunt denticles, the inner one slightly the longer.

Helix lima, Fér. (*Thelidomus*).

Porto Rico. Received mounted from the late Mr. Robert Swift.

Jaw arcuate, thick, high, ends blunt; no median projection to the cutting edge. Anterior surface with 7 stout ribs. A strong, thick muscular attachment to the upper margin.

No lingual membrane received.

Helix marginella, Gmel. (*Caracolus*).

Porto Rico. Received mounted from the late Mr. Robert Swift.

A portion only of the jaw is preserved on the slide. It appears to be thick, arcuate, with strong transverse lines of reinforcement and decided ribs.

Lingual dentition as in *H. excellens* (see plate X., fig. 67).

Helix Chemnitziana, Pfr. (*Pleurodonta*).

Jamaica. Received mounted from the late Mr. Robert Swift.

Jaw stout, arched, ends attenuated, blunt; anterior surface with about 6 irregularly disposed ribs, stout and denticulating either margin.

No lingual membrane received.

Helix Carmelita, Fér. (*Pleurodonta*).

Jamaica. Received mounted from the late Mr. Robert Swift.

Jaw arcuate, ends blunt, anterior surface with about 6 stout ribs, denticulating either margin.

Lingual membrane (plate X., fig. 5) as usual in the *Helicidæ*. Central teeth short, bluntly pointed on the middle cusps, the side cusps subobsolete; laterals like centrals, also with obsolete

side cusps; marginals with oblique bluntly rounded broad cusps, the inner, larger, one bluntly bifid.

Helix punctata (*nux denticulata*), Born. (*Dentellaria*).

Martinique. Governor Rawson.

Jaw stout, arched, ends blunt, cutting edge with a blunt median projection, one stout, decided rib on the centre of the jaw, and three less developed separate ribs at each side of it.

Lingual membrane long and narrow (plate IX., fig. 8). Centrals high and narrow with long, stout median cusps, bearing a point extending nearly to the base of the plate; side cusps subobsolete. Laterals like the centrals, but unsymmetrical. Marginals low, wide, subquadrate, with one very long, broad, bluntly bifid, oblique denticle, and one smaller, bluntly rounded, side denticle.

Helix nucleola, Rang. (*Dentellaria*).

Martinique. Governor Rawson.

Jaw thick, arched, ends blunt; cutting margin with an obtuse median projection. One central, stout rib, denticulating either margin.

Lingual membrane, as usual in *Dentellaria* (see *H. punctata*, Born), above.

Helix formosa, Fér. (*Dentellaria*).

Antigua. Received mounted from the late Mr. Robert Swift.

Jaw arched; ends blunt; several strong, transverse lines of reinforcement, but no ribs; a median projection to cutting edge.

Lingual membrane as usual in the subgenus. (See pl. IX., fig. 8, of *punctata*, Born.)

Helix badia, Fér. (*Dentellaria*).

Received mounted from Mr. Swift.

Jaw stout, arched; ends blunt, with about eight decided ribs.

Lingual membrane as usual in the subgenus. (See pl. IX., fig. 8, of *H. punctata*, Born.)

Pupa rupicola, Say.

Ohio. A. G. Wetherby.

Jaw low, wide, slightly arcuate; ends but little attenuated, blunt; no median projection to cutting edge.

Lingual membrane as usual in the genus. (See figures of that of *corticaria*, *pentodon*, and *badia* in L. & Fr. w. N. A., I.) The cusps on the laterals, however, are very much stouter. There are five perfect laterals.

***Strophia decumana*, Fér.**

Castle Island, Bahamas.

On pl. VIII., fig. 1, will be found figures of the dentition of this species. For full description, see *Annals of Lyc. Nat. Hist. of N. Y.*, x., p. 348.

***Bulimulus chrysalis*, Pfr.**

Martinique. Gov. Rawson.

Jaw of the type common in *Bulimulus*, *Cylindrella*, etc., arcuate, low; ends blunt; thin, transparent; with eighteen narrow, separated ribs; a transverse central line of reinforcement. Attached to the upper margin is a strong triangular membrane of the same consistency and material as the jaw itself, and equally resisting the action of potash, so as readily to be mistaken for the accessory plate of the *Succineæ*. (Pl. V., fig. 11.)

Lingual membrane (pl. V. fig. 12, 13) as usual in the *Helicinæ*. Centrals about as broad as long, tricuspid, the median cusp short and stout, its short point not extending to the base of the plate. Laterals like the centrals, but bicuspid. Marginals wide, low, with one inner, long, blunt, stout, oblique denticle, and one or two short, blunt side denticles.

***Bulimulus Vincentinus*, Pfr., var. ? (*Drymæus*).**

Tobago. Jaw as usual in *Bulimulus*, *Cylindrella*, etc., thin, transparent, with numerous delicate, separated, narrow ribs.

Lingual membrane as in *Bulimulus taticinctus*, etc. (see *Ann. N. Y. Lyc.*, x. pl. xi., fig. 1.)

***Bulimulus Knorri*, Pfr. (*Drymæus*).**

Porto Cabello, Venezuela. Received mounted from the late Mr. Robert Swift.

Jaw arched, high, ends attenuated, blunt; an obtuse median projection to cutting edge; transverse lines of reinforcement, but no ribs.

An unusual form of jaw in this genus, though common in many subgenera of *Helix*.

***Bulimulus Peruvianus*, Brug. (*Plectostylus*).**

Talcahuana. Museum Comparative Zoology.

Jaw as in *Cylindrella*, etc., with about thirty delicate ribs; upper central plate triangular.

Lingual membrane (pl. V., fig. 2) combining the usual characters of the genus with those peculiar to the group of *B. laticinctus*

(referred to above under *B. Vincentinus*). The central tooth is higher than wide, tricuspid, the central cusp short, not extending near the base of the tooth. The laterals (5 in number) are bicuspid, the inner cusp with short, subcircular cutting edge. Marginals of the type of *B. laticinctus* (l. c.).

Bulimus (*Pachyotus*) **egregius**, Jay.

Brazil. J. G. Anthony.

No jaw received.

Lingual membrane as usual in the *Helicidæ*. Centrals and laterals higher than wide, the plates almost extending to the point of the cusps; central with a large median and small side cusps; lateral bicuspid, the inner cusp very large, and bluntly pointed, the outer cusp very small, and acutely pointed. Marginals quadrate, about as high as wide, with one wide, very short, blunt inner cusp, and a similar small outer cusp. (Pl. VI., fig. 1.)

Succinea Barbadosis, Guild.

Barbados. Jaw and lingual membrane as usual in the genus.

Lithotis rupicola, Blanford.

Figs. 3-6 of plate V. represent the jaw and lingual dentition of this species, which are fully described in Ann. Lyc. Nat. Hist. N. Y., x. 346.

Erinna Newcombi, A. Adams.

Sandwich Islands.

Figs. 7-10 of plate V. represent the jaw and lingual dentition of this species, which have been fully described in Ann. of N. Y. Lyc. of Nat. Hist., x. p. 349.

Before closing this paper, I propose reviewing my work on lingual dentition and jaws, for the purpose of ascertaining what reliance may be placed on their characters as a basis for subgeneric distinction, in the genera *Helix* and *Bulimus*. Of *Bulimulus* we cannot yet speak with confidence, so poor is our material.

Sagda.—The genus is included in the *Vitrinea* of von Martens, but we have shown that it belongs to the *Helicea*, the marginal teeth being quadrate, not aculeate.

The jaw has no anterior ribs. In *H. Jayana* there is an approach to a median projection to the cutting edge, but not in *Haldemania* or *Foremaniana*.

The lingual membrane we have examined in *connectens*, *Jayana*,

and *Haldemaniana*. We figure that of the latter (plate IX., fig. 4), with which the others agree. The centrals have their plates short in comparison to the reflection, and broad. The middle cusp is long, with a long slender point. The side cusps are subobsolete, with short, acute, triangular points. The laterals are of same type as centrals, but bicuspid, the outer cusp more developed than the external cusps of the centrals. The marginals are wide, low, with one long, oblique, blunt, narrow inner cusp, and one or more side, small cusps. The dentition and jaw of this species are fully described in Am. Journ. Conch., VII. 175; *S. connectens* in Ibid. 175; *S. Jayana* in Ann. N. Y. Lyc., x. 219.

Leucochroa.—We have shown *L. Boissieri*, Charp., to belong to *Helicea* and not to *Vitrinea*, and expressed our belief that the same will prove true of *candidissima*. (See Ann. N. Y. Lyc., x. 220.) We now figure the dentition (plate IX., fig. 3). The jaw is ribless, with a median projection.

Microphysa is put in *Helicea* by von Martens. *H. minuscula* (see L. and Fr. w. Shells) and *circumfirmata*, Redf. (N. Y. Ann., x. 231), both belong to *Vitrinea*, having aculeate marginal teeth, and jaw of *Zonites*. *H. turbiniformis*, Pfr. (Ann. N. Y. Lyc., x. 79, pl. ii. fig. 2) has a jaw as in *Cylindrella*, *Bulimulus*, etc.—i. e. with numerous very delicate, distant ribs, giving the appearance of separate plates. It would be put in *Goniognatha* of Morch, though there are no upper triangular median plates. We here figure the lingual dentition (plate IX., fig. 7).

For *Patula*, *Gonostoma*, *Polygyra*, *Polygyrella*, *Stenotrema*, *Triodopsis*, *Mesodon*, *Acanthinula*, *Vallonia*, *Aglaja*, *Arionta*, *Euparypha*, *Tachea*, *Pomatia*, *Glyptostoma*, see L. and Fr. w. Shells N. A., I., and our various papers on dentition.

Dorcasia is known to us only by one species, *H. similis*, Fér. (see Am. Journ. Conch., VII. 176). The jaw has eight decided ribs. I figure the lingual dentition (plate IX., fig. 6).

Fruticicola is known to us only by *H. griseola*, Pfr. (see Proc. Phila. Ac. N. S. 1873, 243). The dentition I now figure (plate X., fig. 11).

Coryda.—We have described the lingual membrane only of this subgenus, and that in only one species, *H. Gossei*, Pfr. (Am. Journ. Conch., VII. 177). We figure it on plate IX., fig. 2. The centrals have long, narrow plates, a very short reflection, with a short, blunt median cusp and obsolete side cusps. Laterals like

centrals, but unsymmetrical. Marginals quadrate, with one broad, oblique, long, bluntly bifid inner cusp, and one or two very short rounded side cusps.

Thelidomus.—We have examined *H. aspera*, Fér. (Am. Journ. Conch., VI. 204); *discolor*, Fér. (ante, p. 51); *notabilis*, Shuttl. (Amer. Journ. Conch., VII. 177); *lima*, Fér. (ante, p. 51); and *provisoria*, Pfr. (Ann. Lyc. N. Y., x. 347).

There are 8 decided stout ribs on the jaw of *aspera*, 7 on that of *discolor* and *lima*, on *provisoria* we find 10–15 ribs, less decided than in the other two species.

I figure the lingual dentition of *H. discolor* (plate X., fig. 1). *H. aspera* agrees with it. The marginal teeth of *provisoria* and *notabilis* agree with those of *aspera* and *discolor*, but as the centrals and laterals differ in the shape of the plates and the development of the cusps, I also figure the central and lateral of *notabilis* (plate IX., fig. 10), with which *provisoria* agrees.

Cysticopsis we know by *tumida*, Pfr., and *pemphigodes*, Pfr. For description and figure of the former see Ann. N. Y. Lyc. N. H., IX. 213, f. 3; Am. Journ. Conch., VI. 203, f. 1. Finding the dentition of *pemphigodes* to be different (Am. Journ. Conch., VII. 177) I here figure it (plate IX., fig. 1).

Plagiptycha.—We have published *H. loxodon*, Pfr., *Albersiana*, Pfr., *monodonta*, Lea, *diaphana*, Lea, and *macroglossa*. (See Am. Journ. Conch., VII. 177, 178.) They all agree in having a ribless jaw with blunt median projection to cutting edge, and in dentition such as I figure for *H. macroglossa*, Pfr. (plate X., fig. 10).

Polymita.—We have elsewhere (Ann. N. Y. Lyc., x. 341) pointed out the necessity of revising this subgenus. The typical species *muscarum*, and *H. picta* which must be removed to it from *Liochila*, have a ribless jaw without median projection to the cutting margin (see Am. Journ. Conch., VI. 204, pl. IX., f. 4, 10). The lingual dentition of both species agrees (see *ibid.* and Ann. N. Y. Lyc., x. pl. xvi. fig. 14). It is entirely different from that of any species now known.

Hemitrochus must be used as the name for the balance of the subgenus *Polymita* of von Martens. We have examined *varians*, Mke. (Amer. Journ. Conch., VII. 206, and L. and Fr. w. Shells, I. 185); *Troscheli*, Pfr. (Ann. N. Y. Lyc., x. 343); *graminicola*, Ad. (Am. Journ. Conch., VII. 178); *gallopavonis*, Val. 343. (N. Y. Am. X. 343.) All agree in having an arched ribless jaw with blunt

median projection. All have lingual dentition such as I figure of *graminicola* (plate X., fig. 8).

Liochila.—As stated already (p. 56) *H. picta*, Born, must be removed from this subgenus to *Polymita*, probably also *H. sulphurosa*, Mor.

Eurycratera has decided stout ribs on its jaw. We have seen *H. crispata*, Fér. (Am. Journ. Conch., VII. 179), and *H. angulata*, Fér. (this paper, p. 50). The lingual dentition is essentially the same in each, but on account of difference in the development of the points of the side cusp, I figure that of each (pl. IX. fig. 5; pl. X. fig. 9).

Polydontes has the same type of dentition, as in the last subgenus, as shown in my figure of *H. Luquillensis*, Shuttl. (plate X., fig. 2-4) the only species examined by us. Jaw not seen.

Stylodon.—We have shown *H. militaris*, Pfr. to be a *Nanina* (Ann. N. Y. Lyc., x. 169). Other species unexamined by us.

Erepta.—The same may be said of *H. stylodon*, Pfr. (see ante, p. 48), and *leucostyla*, Pfr., and *rufizonata*, H. Ad. (Ann. N. Y. Lyc., x. 169), all Mauritius species.

Dentellaria.—We have examined a large proportion of the known species. The jaw varies somewhat, so that each description should be studied. There seems a tendency to a median projection to the cutting edge, and to the presence of ribs. *H. pachygastra*, Gray (Ann. N. Y. Lyc., x. 305) has 7 decided ribs and no median projection. *H. orbiculata*, Fér. (Am. Journ. Conch., VI. 205, pl. ix. f. 14) has traces of ribs and no median projection. *H. Isabella*, Fér. (l. c. VII. 179) has decided ribs and no median projection. *H. dentiens*, Fér. (Am. Journ. Conch., VII. 179) has decided ribs and no median projection. *H. nucleola*, Rang (ante, p. 52) has one decided rib and a median projection. *H. badia* (ante, p. 52) has 8 decided ribs. *H. formosa*, Fér. (ante, p. 52) has no ribs, but a strong median projection. *H. perplexa*, Fér. (Ann. N. Y. Lyc., x. 221) has obsolete ribs and median projection. *H. lychnuchus*, same as last (Ann. N. Y. Lyc., x. 221, pl. xiv. f. 5, 7). *H. punctata*, Born (ante, p. 52) has median projection and decided ribs. *H. Josephinæ*, Fér. (Ann. N. Y. Lyc., x. 306) is strongly arched, has no ribs, but a median projection.

All the above species agree in their dentition. See figure of that of *lychnuchus* (l. c.) and of *punctata* (plate IX., fig. 8 of this paper.)

Pleurodonta.—The jaw in *Chemnitziana*, Pfr. (ante, p. 51) has 7 stout, separated ribs; *Carmelita*, Fér. has 6 (ante, p. 51); *acuta*, Lam. (Amer. Journ. Conch., VI. 204) has 7 ribs.

The lingual membrane is the same as I figure for *Carmelita* (plate X., fig. 5) in *Schroteriana* (Amer. Journ. Conch., VII. 179), in *invalida*, Ad. (Ann. N. Y. Lyc., x. 179). In *acuta*, Lam. the centrals and laterals are of the same type, but the marginals have only one long, wide, blunt denticle, slightly bifid at end. In this respect it is more like *Caracolus* than the other species of *Pleurodonta* examined by us.

Caracolus.—We have shown *H. Bermudensis*, Pfr. (Ann. N. Y. Lyc., x. 221) to belong to *Vitrininae*; *H. inversicolor* (l. c. x. 169) to *Nanina*.

The jaw in *H. marginella*, Gmel. (ante, p. 51) appears to be ribbed.

I figure (plate X., fig. 6-7) the lingual dentition of *H. excellens*, Pfr. (Am. Journ. Conch. VII. 180). *H. marginella*, Gmel. agrees with it, excepting that the cusps of the marginals are shorter.

Leptoloma.—We have described only *H. fuscocincta*, Ad. (Am. Journ. Conch., VII. 180). The jaw has a median projection, but no ribs. The lingual I figure on plate IX., fig. 9.

Acavus.—*H. phoenix*, Pfr. has a ribless jaw (Am. Journ. Conch., VII. 180). Its dentition is figured on plate IX., fig. 11.

In *Bulimus* we have examined the following genera:—

Macrodontes we know by *B. odontostomos* (Am. Journ. Conch., VI. 209). The jaw is ribless. The dentition is figured on plate VI., fig. 7.

Pelecychilus we know from *B. aurissileni*, Born (Ann. Lyc. N. H. N. Y., x. 229), and *B. glaber*, Gmel. (not before published); both have delicate ribs as in *Bulimulus*, *Cylindrella*, etc. The dentition of the former is given on plate VI., fig. 4; of the latter on plate VI., fig. 6.

Anthinus we know from *B. multicolor*, Rang (Am. Journ. Conch., VI. 208). The jaw is ribless. Lingual dentition given on plate VI., fig. 8.

Pachyotus we know from *B. egregius*, Jay (see this paper, p. 54). Jaw not examined. Lingual dentition figured on plate VI., fig. 1.

Borus.—We have examined *B. oblongus*, Mull. Its ribbed jaw and lingual dentition are figured by Heynemann (Mal. Blatt., xv.).

Of *Orphnus* we have examined one species, *B. Hanleyi*, Pfr. (Am. Journ. Conch., VI. 208). The jaw is ribless, with a median projection. The lingual dentition is given on plate VI., fig. 5.

Dryptus we have examined in two species, *B. pardalis*, Fér. (Am. Journ. Conch., VII. 181) and *B. marmoratus*, Dunk. (l.c.). The jaw of the latter is unknown. In the former it is ribbed. The lingual dentition of *B. marmoratus* is given on plate VI., fig. 2. In *B. pardalis* it has not been examined.

Eurytus we know from only one species, *B. aulacostylus*, Pfr. (Ann. Lyc. N. H. N. Y., x. 282). The jaw has delicate ribs as in *Bulimulus*, *Cylindrella*, etc. The lingual dentition is given on plate VI., fig. 3.

A comparison of the figures I have given of the lingual dentition of the subgenera of *Bulimus* shows a greater constancy in that genus than in *Helix*, especially as regards the marginal teeth.

I add a figure of the dentition of *Cochlostyla fulgetrum*, Brod. (plate V., figs. 14-16). See Am. Journ. Conch., VII. 180.

EXPLANATION OF THE PLATES.

PLATE II.

- A. *ARIOLIMAX NIGER*, J. G. Cooper. The tail enlarged to show the caudal mucus pore. From the type in the California State Collection, preserved in spirit.
- B. *ARIOLIMAX COLUMBIANUS*? The tail, slightly enlarged, of a specimen from Mr. Hemphill (see p. 35) showing the mucus pore. It must be borne in mind that the specimen has long been preserved in spirit.
- C. *ARIOLIMAX COLUMBIANUS*? A specimen from San Mateo Co., California, received from Mr. Henry Hemphill (see p. 38). The genitalia about life size.
1. The testicle.
 2. The epididymis.
 3. The accessory gland of the last?
 4. The prostate gland.
 5. The sac of the penis.
 6. The retractor muscle of the penis.
 7. The vas deferens.
 8. The oviduct.

- 9. The genital bladder.
- 10. The external orifice of the genitalia.
- 11. The ovary.
- 16. The duct of the genital bladder.
- D. A portion of the digestive organs of the same.
 - 1. The buccal mass.
 - 2. The œsophagus.
 - 3, 3. The ducts of the salivary glands.
 - 4, 4. The salivary glands.
 - 5. The pouch of the lingual membrane.
- E. The same; an extreme marginal tooth of the lingual membrane.
- F. Same as last—life size.
 - 1–4. See fig. D.
 - 5. The stomach.
 - 6. The blind sac of the same.
 - 7, 7. The biliary ducts.
 - 8. The intestine.
 - 9. The rectum.
- G. The same. The rudimentary internal shell.
- H. The same. The jaw.

PLATE III.

- Fig. I. *ZONITES LÆVIGATUS*, Raf. The genital system. Same references as in pl. II. fig. c.
 - 13. Dart sac? See p. 39.
- Fig. II. *Helix reticulata*, Pfr. = *RAMENTOSA*, Gld. Genital system. Same references as in fig. 1.
 - 13. Vaginal prostate.
 - 13*a*, *a*. Flagella of same.
 - 15. Flagellum of penis.
 - 16*a*. Accessory to duct of genital bladder.
- Fig. III. *HELIX MITCHELLIANA*, Lea. Genital system. Same references as in fig. I.
- Fig. IV. *HELIX KELLETTI*, Forbes. Genital system. Same references as in fig. II.
 - 14. Dart sac? See page 40.
- Fig. V. *HEMPHILLIA GLANDULOSA*. Genital system. Same references as in fig. I.
- Fig. VI. The same. See page 39 for 5*a* and 5*b*.

PLATE IV.

Fig. I. Genitalia of *MACROCYCLIS VANCOUVERENSIS*, Lea.

1. Testicle.
2. Epididymis.
3. Accessory gland.
4. Prostate.
5. Sac of penis.
7. Vas deferens.
8. Oviduct.
9. Genital bladder.
10. External orifice.
11. Ovary.
14. Dart sac? vaginal prostate?
16. Duct of genital bladder.

Fig. II. Genitalia of *PATULA STRIGOSA*, Gld. Same references as in fig. I.

Fig. III. Genitalia of *HELIX NICKLINIANA*, Lea. Same references as in fig. I.

6. Retractor muscle of penis.
13. Vaginal prostate.
- 13a. Flagellum to last.
15. Flagellum to penis.
- 16a. Accessory duct to the genital bladder.

Fig. IV. Genitalia of *HELIX APPRESSA*, Say. Same references as in fig. I.

Fig. V. Genitalia of *H. ROEMERI*, Pfr. Same references as in fig. I.

PLATE V.

Fig. 1. Lingual dentition of *HELIX TEXASIANA*, Mor. Central, lateral, and marginal teeth.

Fig. 2. Same of *BULIMULUS PERUVIANUS*, Brug.

Fig. 3. *LITHOTIS RUPICOLA*, Bl. Jaw.

Fig. 4. Same; central and lateral teeth.

Fig. 5. Same; marginal teeth.

Fig. 6. Same; extreme marginal teeth.

Fig. 7. *ERINNA NEWCOMBI*, A. Ad. Jaw.

Fig. 8. Same; central and lateral teeth.

Fig. 9. Same; marginal teeth.

Fig. 10. Same; extreme marginal teeth.

- Fig. 11. *BULIMULUS CHRYSALIS*, Pfr. Jaw.
 Fig. 12. Same; central and lateral teeth.
 Fig. 13. Same; marginal teeth.
 Fig. 14. *COCHLOSTYLA FULGETRUM*, Brod. (*Canistrum*); central and lateral teeth.
 Fig. 15. Same; first marginal teeth.
 Fig. 16. Same; extreme marginal teeth.
 Fig. 17. *HELIX WETHERBYI*, Bland; central and lateral teeth.
 Fig. 18. Same; marginal teeth.

PLATE VI.

Central, lateral, and marginal teeth of—

- Fig. 1. *BULIMUS EGREGIUS*, Jay (*Pachyotus*).
 Fig. 2. MARMORATUS, Dunk. (*Dryptus*).
 Fig. 3. AULACOSTYLUS, Pfr. (*Eurytus*).
 Fig. 4. AURIS-SILENI, Born (*Pelecychilus*).
 Fig. 5. HANLEYANUS, Pfr. (*Orphnus*).
 Fig. 6. GLABER, Gmel. (*Pelecychilus*).
 Fig. 7. ODONTOSTOMUS, Sowb. (*Macrodontes*).
 Fig. 8. MULTICOLOR, Rang. (*Anthinus*).

PLATE VII.

- Fig. A. *AMPHIBULIMA PATULA*, Brug. Dominica.
 Fig. B. Same, to show variations in cusps of laterals.
 Fig. C. *AMPHIBULIMA PATULA*. St. Kitts, see p. 44.

PLATE VIII.

- Fig. 1. *STROPHIA DECUMANA*, *a*. Central and lateral teeth; *b*. marginal teeth.
 Fig. 2. *AMPHIBULIMA RUBESCENS*, Desh. Jaw.
 Fig. 3. Same. Lingual membrane. *a*. Central and lateral teeth; *b*. marginal teeth; *c*. extreme marginal teeth.
 Fig. 4. Same. Genitalia.
 Fig. 5. *AMPHIBULIMA APPENDICULATA*, Pfr. Genitalia.
 Fig. 6. Same. Lingual membrane. *a*. Central and lateral teeth; *b*. marginal teeth.
 Fig. 7. *GONOSPIRA NEWTONI*, H. Ad. Genitalia.

PLATE IX.

Lingual dentition; central, lateral, and marginal teeth of—

- Fig. 1. *HELIX PEMPHIGODES*, Pfr., *Cysticopsis*.

- Fig. 2. *HELIX* GOSSEI, Pfr., *Coryda*.
 Fig. 3. *HELIX* BOISSIERI, Charp., *Leucochroa*.
 Fig. 4. *HELIX* HALDEMANIANA, Ad., *Sagda*.
 Fig. 5. *HELIX* ANGULATA, Fér., *Eurycratera*.
 Fig. 6. *HELIX* SIMILARIS, Fér., *Dorcasia*.
 Fig. 7. *HELIX* TURBINIFORNIS, Pfr., *Microphysa*.
 Fig. 8. *HELIX* PUNCTATA, Born, *Dentellaria*.
 Fig. 9. *HELIX* FUSCOCINCTA, Ad., *Leptoloma*.
 Fig. 10. *HELIX* NOTABILIS, Fér., *Thelidomus*.
 Fig. 11. *HELIX* PHOENIX, Pfr., *Acavus*.

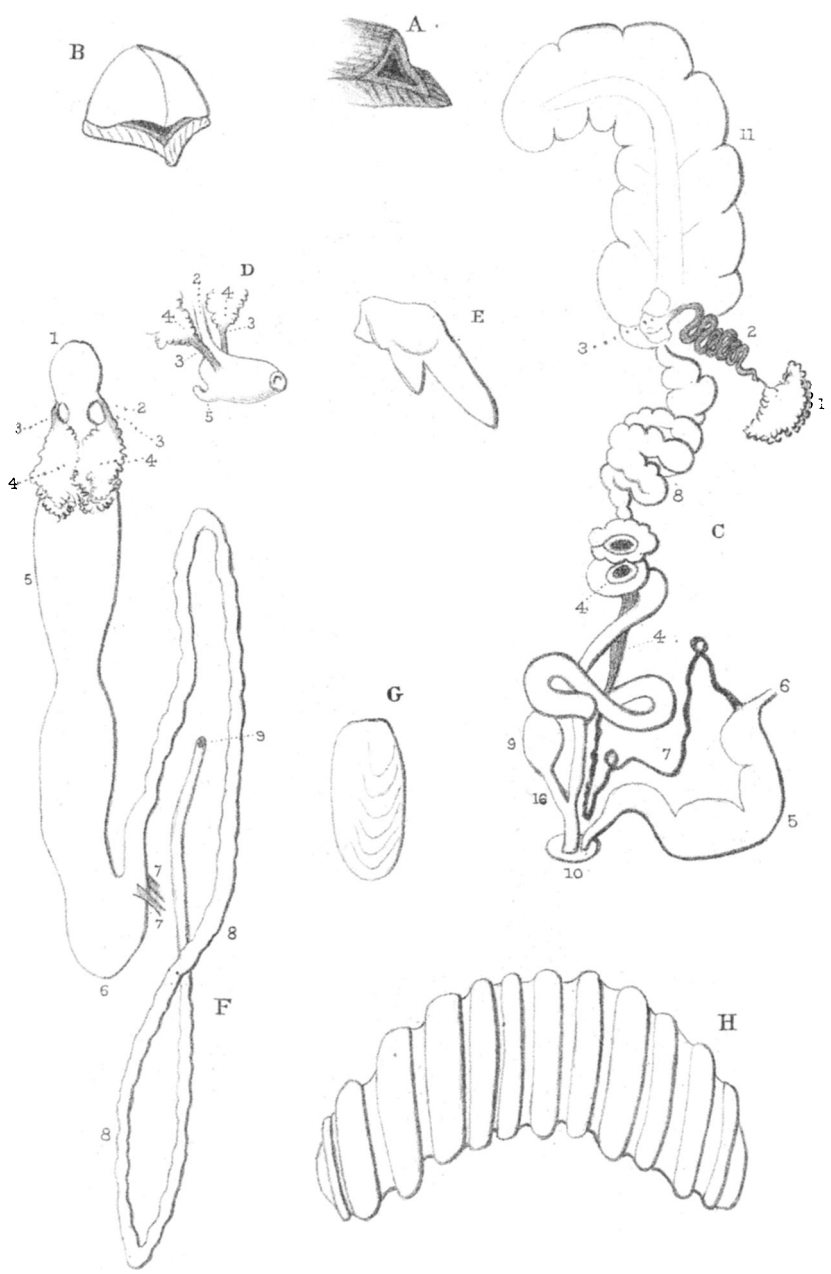
PLATE X.

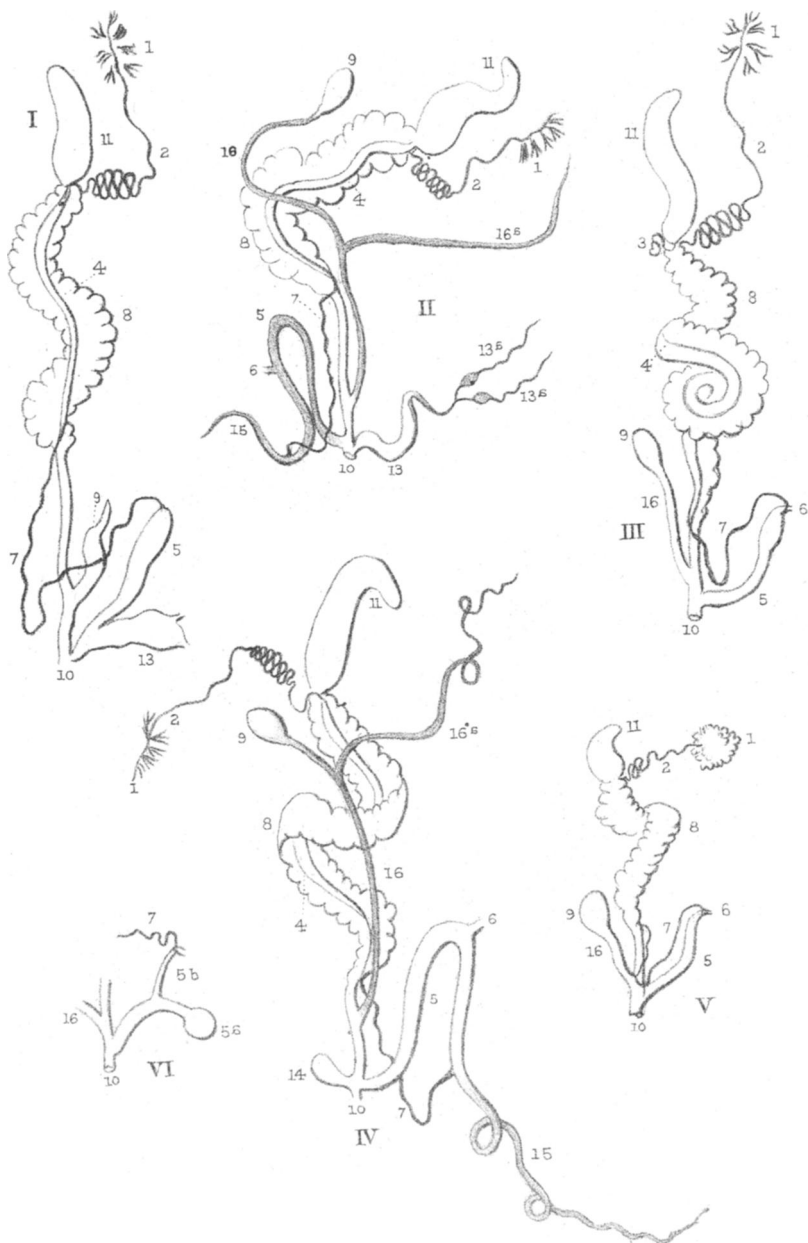
Central, lateral, and marginal teeth of lingual membrane of—

- Fig. 1. *HELIX* DISCOLOR, Fér., *Thelidomus*.
 Fig. 2, 3, 4. *HELIX* LUGUILLENSIS, Shuttl., *Polydontes*.
 Fig. 5. *HELIX* CARMELITA, Fér., *Pleurodonta*.
 Fig. 6, 7. *HELIX* EXCELLENS, Pfr., *Caracolus*.
 Fig. 8. *HELIX* GRAMINICOLA, Ad., *Polymita*.
 Fig. 9. *HELIX* CRISPATA, Fér., *Eurycratera*.
 Fig. 10. *HELIX* MACROGLOSSA, Pfr., *Plagioptycha*.
 Fig. 11. *HELIX* GRISEOLA, Pfr., *Fruticicola*.

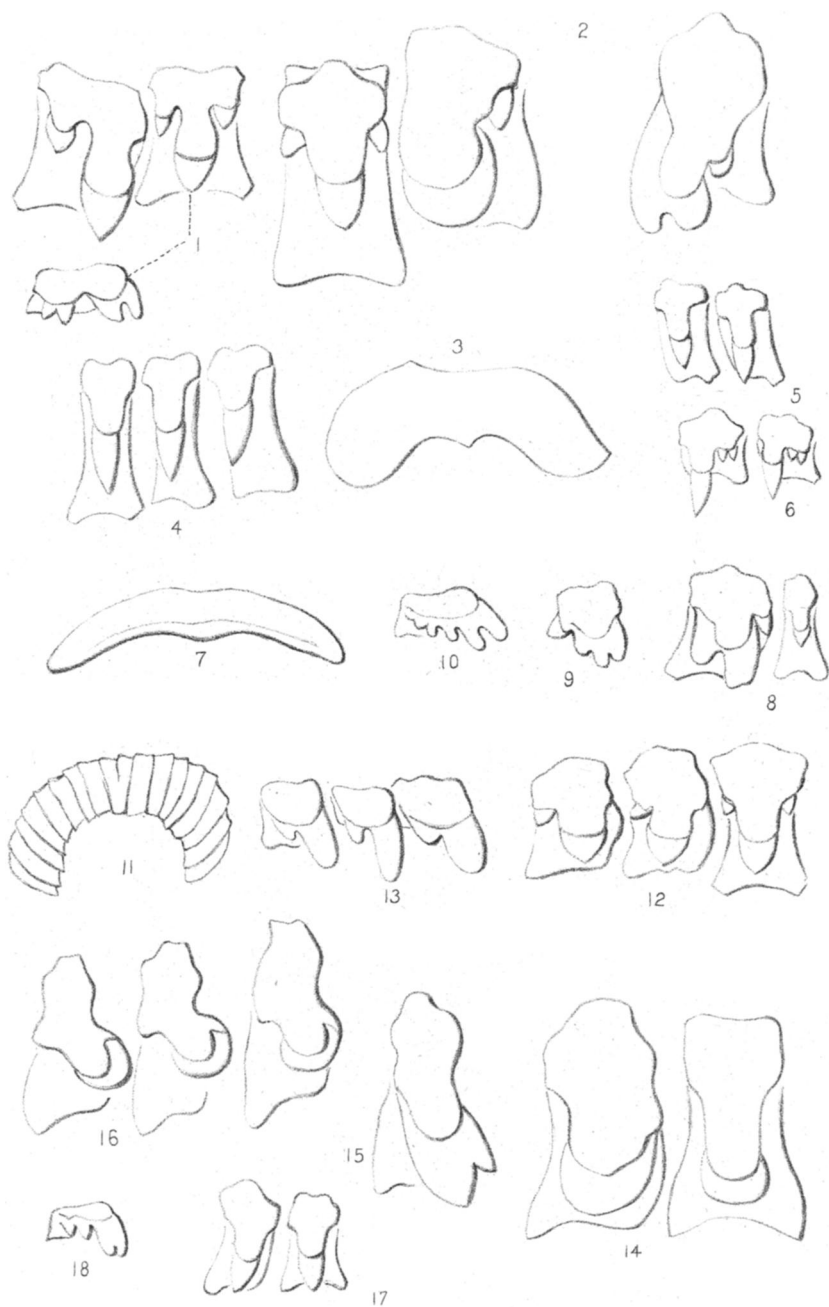
PLATE XI.

- A. *ARIOLIMAX* NIGER, J. G. Coop. From the type in the California State collection. Extreme marginal teeth from the lingual membrane.
 B. Same as last. The central tooth and first lateral teeth.
 C. Same as last. The genitalia enlarged. References same as in fig. C. of plate II.
 13. The vaginal prostate.
 D. *ARIOLIMAX* CALIFORNICUS? From a specimen from San Mateo, Cal., in the Museum of Comparative Zoology. The genitalia slightly enlarged. Same references as in last figure, excepting 15, the flagellum.
 E. Same as last. The digestive organs, life size. Same references as in fig. F. of plate II.
 F. The same. 1. Central tooth; 2. first lateral tooth of the lingual membrane.
 G. The same. Extreme marginal tooth of the lingual membrane.

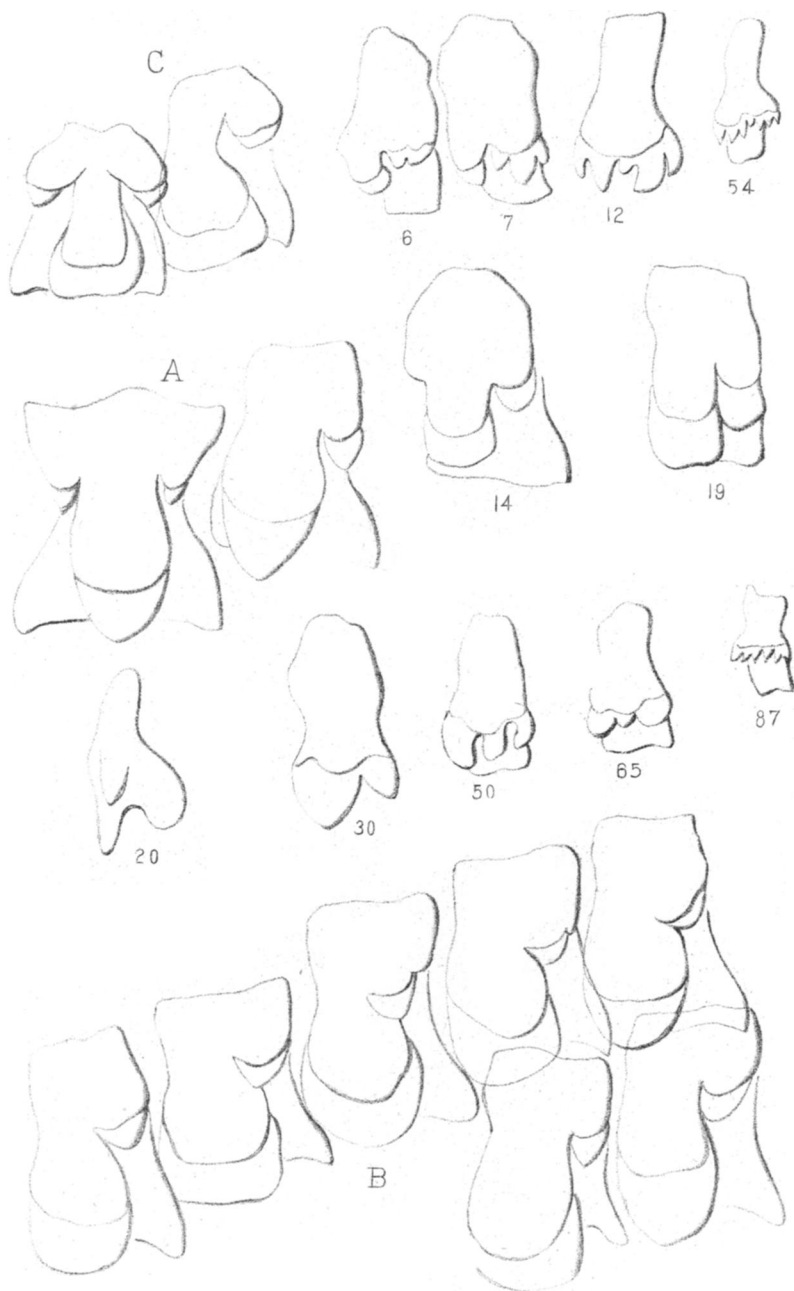


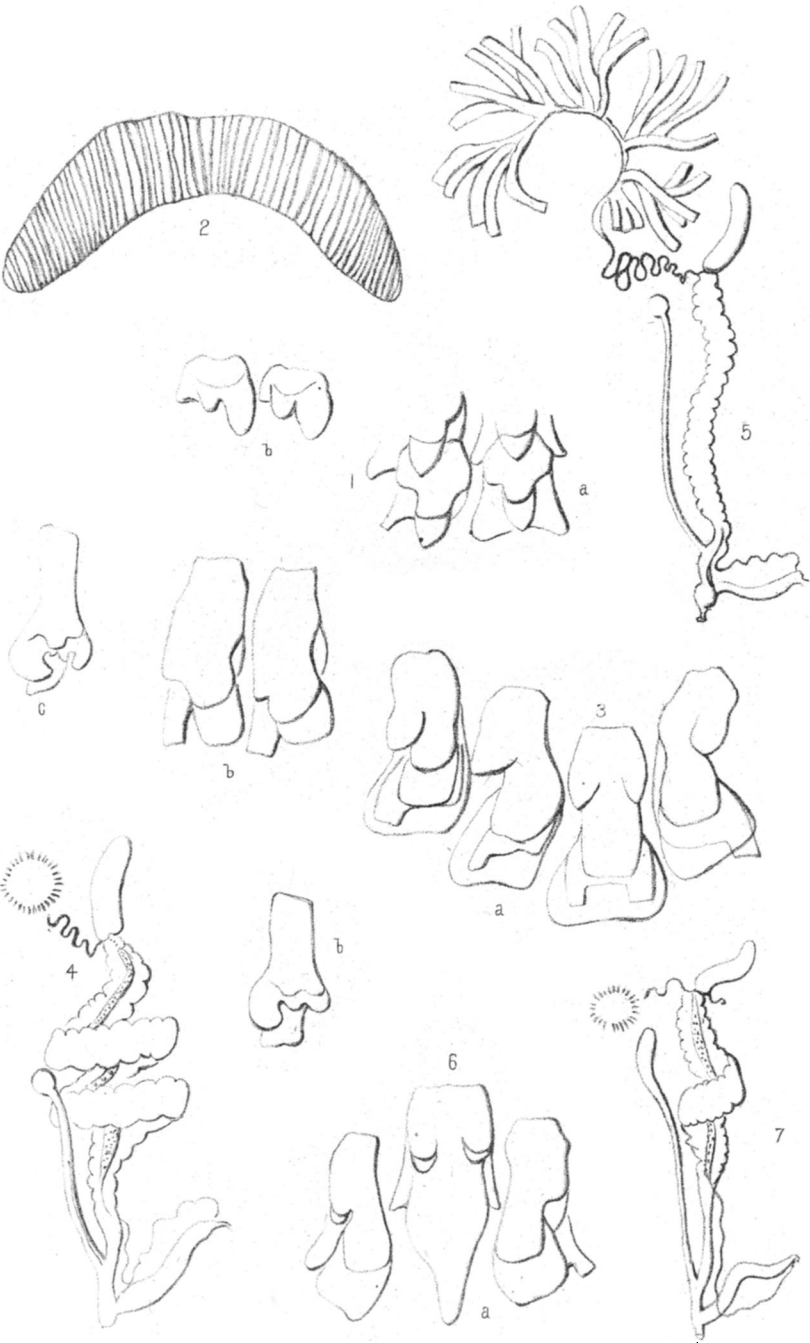


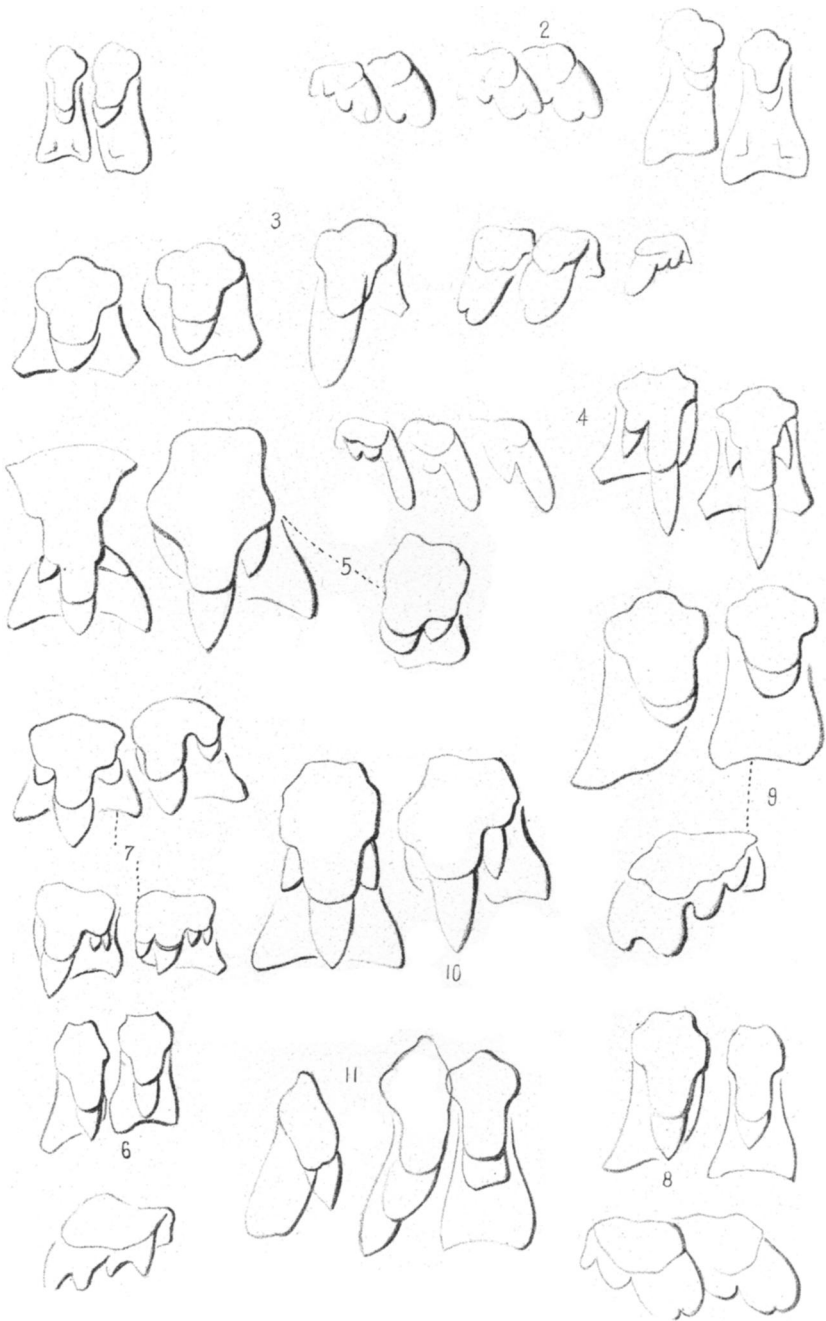






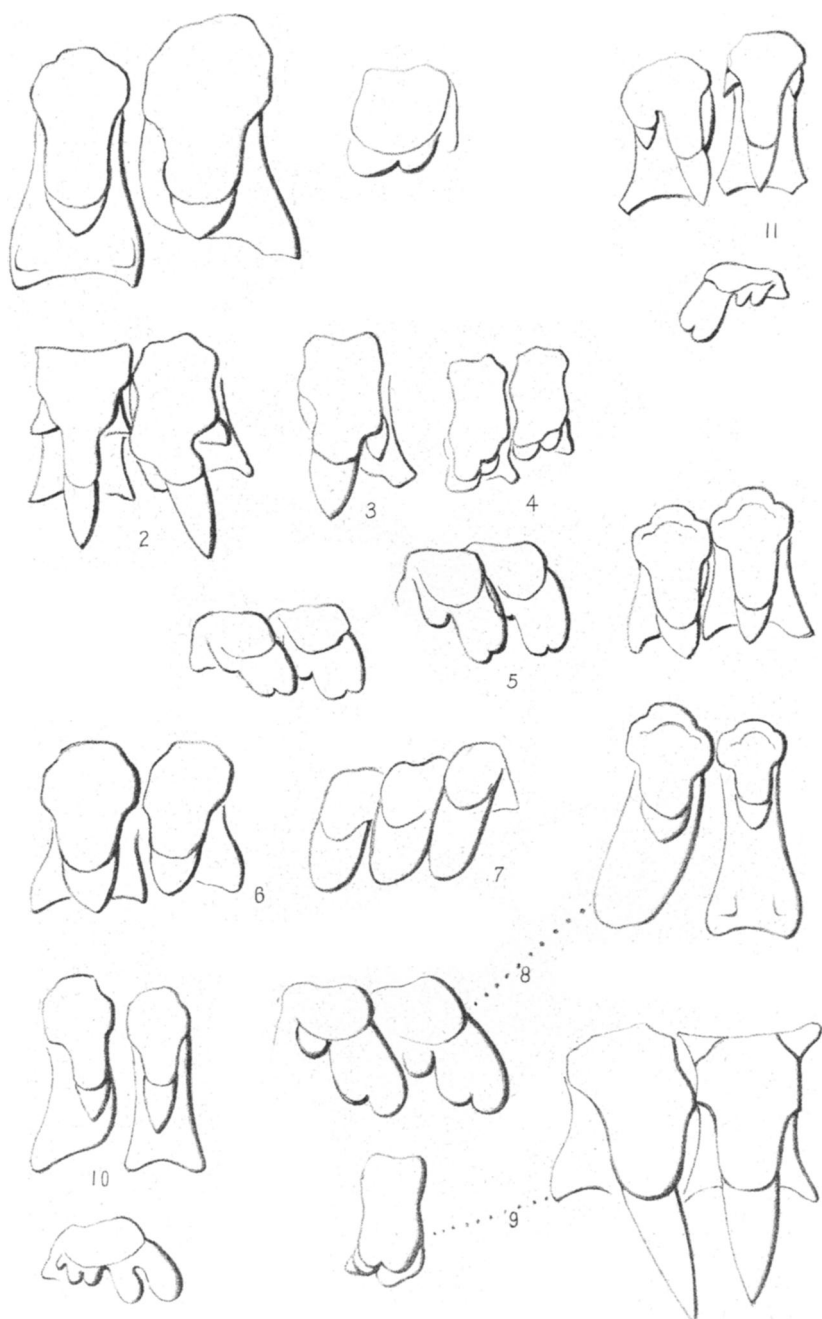


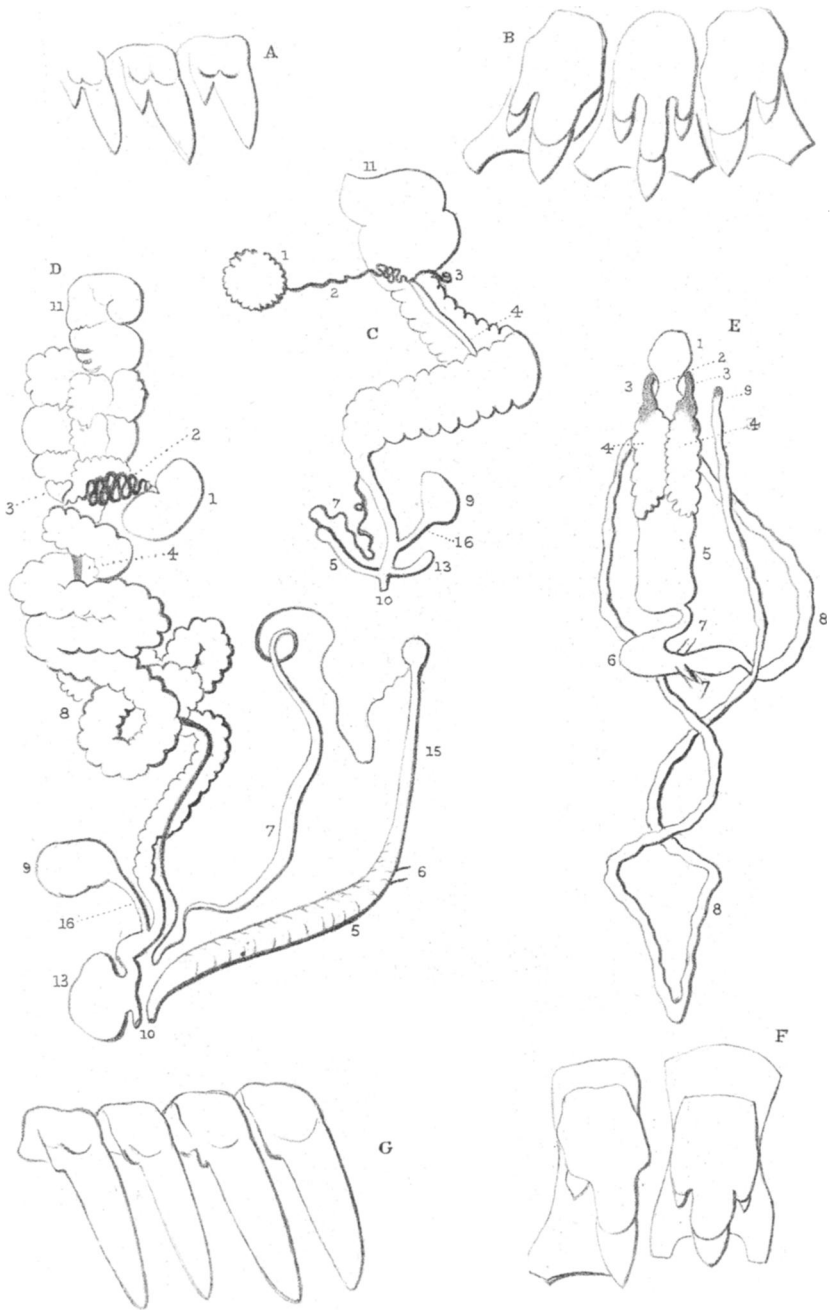




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